however, not to be adduced as examples for imitation, being of that description, in which excess of material supplies the place of calculation and knowledge of the strength of materials. Timber piers should never be employed where it can be avoided, for the alternate moisture and dryness to which they are subjected, renders them in a constant state of decay. Some saving is effected by driving separate piles, the heads of which can be always beneath the surface of the water, and erecting the piers upon them; thus, repairs can be conducted with much greater facility, and there is no occasion to remove the piles, which are preserved by the constant immersion. But it is at best an objectionable method, and the piers are also subject to injury from ice and the passage of vessels, though precautions may be always taken for protecting them from these latter injuries.

The bridge of Sublicius, which existed at Rome in the reign of Ancus Martius, about 500 years before the Christian era, is the oldest wooden bridge of which we have any account. It is said to have been put together without iron or nails, and could be taken to pieces. Cæsar's bridge, erected in ten days for the passage of his army across the Rhine, is described in his "Commentaries," but not with sufficient clearness to admit of a satisfactory restoration of the design. Alberti, Palladio, and Scamozzi have all made the attempt, but their representations are very different. Trajan's bridge over the Danube, from the representation upon the column, would appear to have been of a more advanced system of construction. Each arch, believed to have been upwards of 100 feet span, was formed of concentric curved ribs of timber, connected by radial pieces. The piers appear to have been of stone.—During the middle ages, timber bridges were frequently employed. They were built on piles, which were so numerous, as to oppose considerable resistance to the current, so that, notwithstanding the means taken to protect them, they were not unfrequently carried away by floods. According to Tredgold, who has devoted considerable space, in his work, to this branch of carpentry, Palladio was the first architect who made any important improvement in the construction of timber bridges. In his treatise on architecture, he first illustrated the principles of several methods of construction, upon which some of the most important works of modern times are merely modifications. He is also considered to have been the first who made the important changes in construction by which a considerable number of piers could be dispensed with. In the bridge which he erected over the Cismone, near Bassano, there is but one span, which is 108 feet. It is a modification of the ordinary queen-post truss. To him is also attributed the system of construction, in framed *voussoirs*, an arrangement of diagonal tracing, acting in similar manner to the voussoirs of a stone bridge. In the bridge over the Brenta, which has four piers, and is in length 194 feet, the principal support is given by struts butting upon the ends of one horizontal piece, in the same way as the principals and collar of a queen-post roof. The bridge, like many in Switzerland and Italy, is covered, having a colonnade for the support of the roof. It has been doubted whether covering a bridge increases the durability sufficiently for the additional outlay; but apart from the advantage of such protection for the passenger along an exposed situation, it can hardly be questioned that in mountainous countries, and where avalanches are to be expected, a roof may often prevent the way being impeded, if not frequently the entire destruction of the bridge. Of later methods of construction, applicable to timber bridges, the most important is that in which curved ribs form the support, and which was first recommended by Price in the "British Carpenter." He proposed to make the rib with a rise of about one-sixth the opening, dividing it into any convenient number of pieces, each rib, for a bridge of 36 feet span, consisting of two thicknesses, each three inches in thickness, keyed together with wooden keys and "breaking joint." A further modification, lately used for large viaducts in the north of England, is that so frequently employed by Wiebeking, in which, instead of forming the curved ribs of short lengths, pieces of considerable length, bent to the form of the curve, are employed. The ribs are usually composed of several thicknesses, bent over each other in concentric curves, keyed or bolted together. A further improvement for large spans, is by employing two of these ribs placed some distance apart, diagonal bracing being inserted.

The variety of forms in which the different principles of framing are found in timber bridges, in all parts of Europe and America, is very great, and we shall perhaps best dismiss this part of our subject by referring our readers to Mr. Cresy's "Encyclopedia of Civil Engineering," where considerable space is devoted to this branch of architecture. In that work, and in Tredgold's "Principles of Carpentry," some of the methods in use, and the gradual eduction of one from another, are clearly elucidated. They may be thus enumerated:—First, omitting the simplest form, in which the span is so narrow as to require merely timbers laid over the opening, we have the form noticed first as used by Palladio. In this, a tie is the important characteristic, consequently, it can be used without much provision for abutment; struts radiating from each end of the tie, support a corresponding continuous timber above, from which depend timbers or rods for the support of the tie. Many bridges have been built on this principle in Switzerland, where carpentry is well understood. That at Schaffhausen, constructed in 1757, by a village carpenter, had two spans, one, 172 feet, and the other, 193 feet, with a stone pier in the middle: the construction displayed remarkable skill, nevertheless it proved that the oak beams which rested on the masonry of the pier and abutments, had not been sufficiently seasoned, nor disposed so as to admit of a circulation of air round them. They became rotten, so that it was necessary to raise the whole structure by means of screw-jacks, and to replace the decayed timbers with others of sound quality. It has been considered to be a defect in this bridge, that all the principal supports are so dependant upon each other, that no portion could be removed without great difficulty; still, and although, as it has been stated, "a man of the slightest weight felt it almost tremble under him," it remained forty-two years, until it was burnt by the French army, without requiring any other repair than that already mentioned. When the immense outlay required for the maintenance of a bridge such as that of Westminster, commenced little more than one hundred years since, is considered, it will not be thought, that the lighter material contrasts unfavourably with stone. The next variations in construction are when the abutments are adequate to resist the thrust. One of these, also used in Switzerland, is where struts are inclined from the abutments, parallel to each other, to support the roadway at the centre, and intermediate points. These struts are strengthened and supported at intervals, from the roadway, by perpendicular timbers. This principle, however, requiring long timbers, which are sometimes obtained with great difficulty, has had frequently to be modified on the principle of butting timbers end to end, adopted by Palladio in the bridge over the Brenta. Other modifications of that principle are when the arrangment of the supporting combination is in four or five pieces instead of three. The arrangement has, however, great objections, and is little calculated, by reason of the difficulty of giving sufficient strength at the joinings, to resist a variable load. The bridge at Walton, and that at Sault, on the Rhone, which failed, the first in twenty years, and the latter in thirteen years, would argue against the use of this kind of framing.

But the use of curved ribs, arranged in either of the methods already mentioned, does not possess the disadvantages to be found in beams which merely abut end to end. Of the bridges constructed by Wiebeking, that at Bamberg, on the Reignitz, in Germany, consists of one arch of 208 feet span, with a rise of 16·9 feet, and the description of this bridge and others erected by the same architect, should be read by all who are engaged in the construction of timber bridges. The bridge at Bamberg was built in 1809. The joints of all the parts, built into the abutments, were well soaked in hot oil, and also covered with sheet-lead. In the bridge at Freysingen, small gutters were made at the lower end of the curved ribs and braces, to cause the water to run off instead of settling in the joints, and to all the principal timbers, two coats of pitch and tar were applied. It is to be regretted that many of the bridges by Wiebeking are boarded over and painted in imitation of stone-work, which, whilst it is a most unsatisfactory attempt at deception, is of very doubtful efficacy in preserving the timbers from decay.

The use of diagonal bracing framed between concentric ribs of continuous timber, seems to be the method of construction in most cases entitled to the preference over others.—Amongst other kinds of bridges are those in which the arched rib springs from the level of the roadway, which is suspended from it, a method which has many advantages, where it is difficult to form abutments, or when it is necessary to keep the roadway as low as possible. Several of the new iron bridges on the railways are on this principle. In foot bridges the requisite strength is often gained by trussing the railing on each side the roadway. Iron has been frequently employed with great advantage for suspension in timber bridges, either various modifications of the ordinary principle, or in long beams requiring no other support, as a truss beneath them.

It is in America that the greatest novelty has been displayed in timber bridges. These are frequently constructed of arrangements of diagonal bracing, and have great strength without lateral thrust. In what are called lattice bridges, from their appearance resembling lattice work, a span of 150 feet can be covered without difficulty: materials of small scantling are required; the lattice framing for a span of 80 to 150 feet, being formed of fir planks about three inches in thickness and 12 inches wide, arranged to cross each other at right angles. The points of intersection are united by oak tree-nails, 1¼ inch in diameter. The depth of the lattice-work in bridges of 75 feet span is about 9 feet 6 inches: the roadway is supported along the top by a longitudinal rib at each side; these ribs are connected by cross timbers and diagonal bracing. The greatest care is requisite to have the timbers well seasoned. Such bridges have been constructed of great extent; one on the New-York and Haerlem railway is said to be 736 feet in length and has only four stone piers. Long's American bridge, which bears a nearer resemblance to the one we have engraved, has, like it, an arrangement of diagonal bracing with upright posts, framed between string-pieces, each formed of three timbers. It differs however, in some important details, from that at Chambly.

The inventor of the method of bridge building represented in the illustration, is Mr. Howe, of Springfield, Massachusetts. He obtained a patent for the United States, which he disposed of to Messrs. Boody, Stone, and Co., who erected the bridge at Chambly, and have built a number on the same plan for railways of much greater span. The original design in this case, was for a bridge of 960 feet in length, having five piers and two abutments, but an error having been discovered in the measurement of 77 feet, there are actually six piers, one of the spans being 77 feet. The piers and abutments have also been raised three feet higher than as at first intended, which has been done by adding masonry beneath the chords, or string-pieces, as shewn in the transverse section, fig. 3. The piers are all in the water, which extends from bank to bank; the river is seldom flooded, but the current is swift, and substantial masonry is of course necessary to resist the ice. The specification required the masonry to be laid in courses, between 12 and 24 inches thick, so as to form a solid mass, in hydraulic cement, in the proportion of two parts of sand to one of cement. The piers to be 16 feet wide, by at least 23 feet long at the top, exclusive of a triangular ice-breaker, and are battered one inch to the foot, on all sides except on the cut-water, where the batter is four inches to the foot. The up-stream end of the piers was specified to be dowelled one stone to the other above and below it on the ice-breakers, and five or six feet past the angles. The dowelling to extend to high water, including the foundation course, which was to be dowelled, in like manner, to the rock in the bed of the river.

The superstructure was to be framed in spans about 154 feet to 160 feet: the trusses to be 18 feet high from top to bottom of the chords, and 22 feet 1 inch wide from outside to outside. The carriage-way to be 12 feet in the clear between the trusses, and divided in the centre by a timber, 5 inches by 8 inches,

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